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All-fibered high-quality low duty-cycle 40-GHz picosecond pulse source based on nonlinear compression of beselons

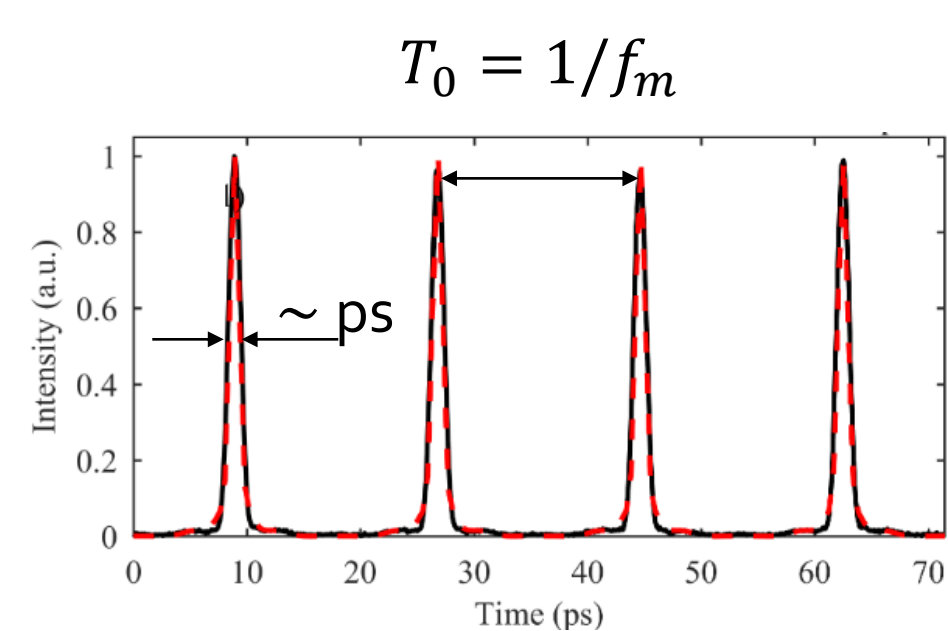


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INTRODUCTION

GOAL : Ultrashort pulse train generation at high repetition rates using a simple all optical setup

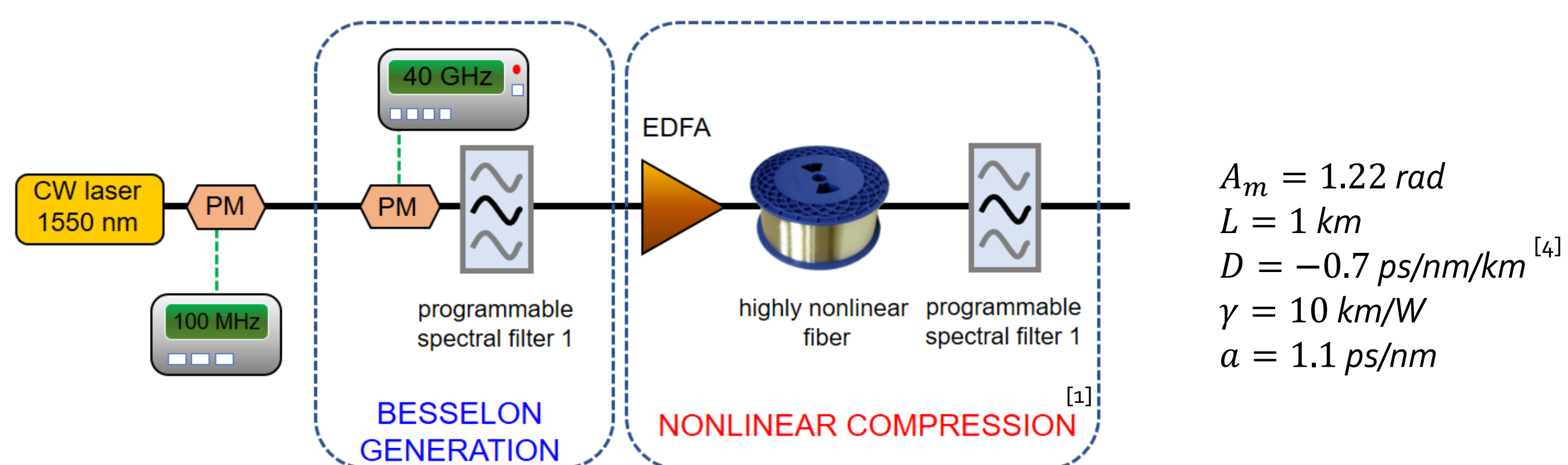


$$f_m \sim 5-100 \text{ GHz}$$

$$\text{Duty Cycle, } D = \frac{\text{FWHM}}{T_0} \ll 1$$

$$\text{Extinction Ratio, ER} = \frac{I(T_0)}{I(T_0/2)} \rightarrow \infty$$

I. EXPERIMENTAL SETUP



$$A_m = 1.22 \text{ rad}$$

$$L = 1 \text{ km}$$

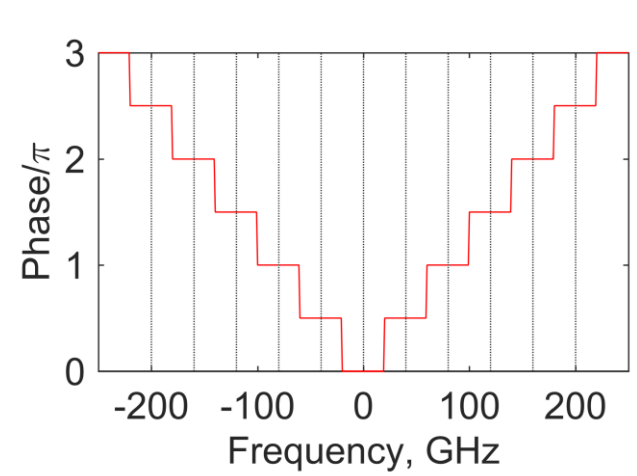
$$D = -0.7 \text{ ps/nm/km} \quad [4]$$

$$\gamma = 10 \text{ km/W}$$

$$\alpha = 1.1 \text{ ps/nm}$$

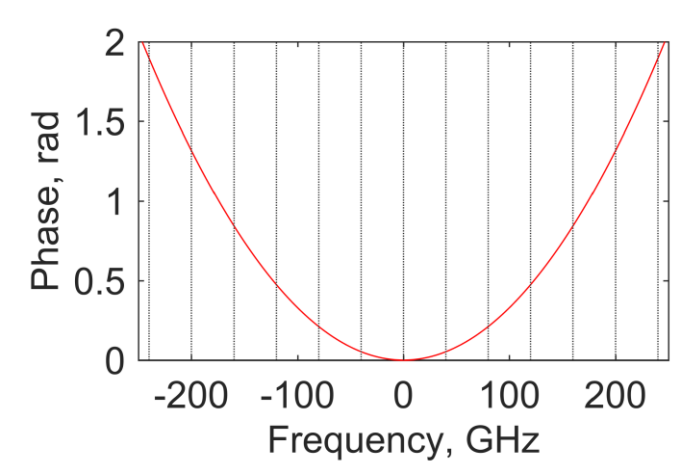
WaveShaper #1

Triangular step phase generates the Besselon waveform

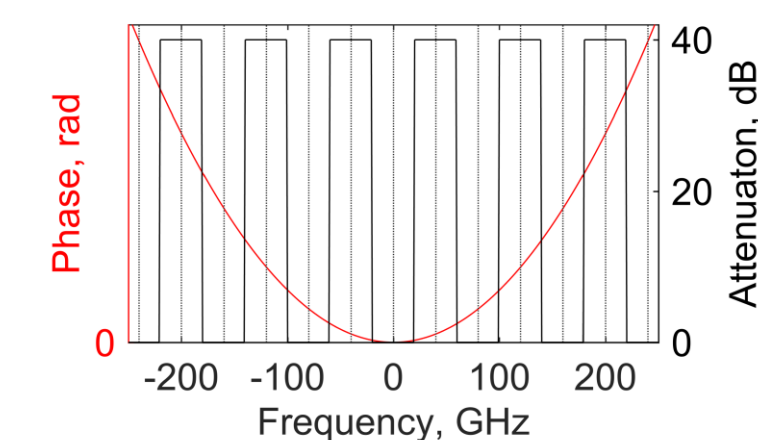


WaveShaper #2

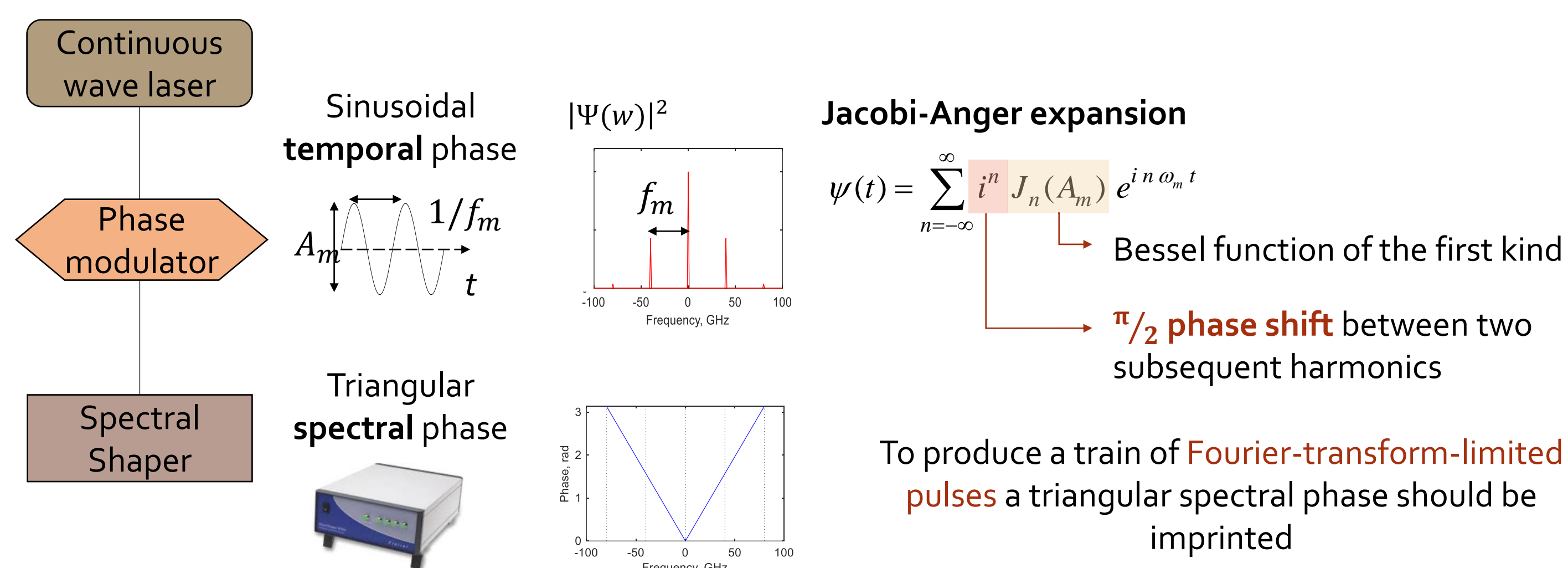
Quadratic phase compensates induced chirp [2, 5]



Suppression of spectral lines allows to multiplex the repetition rate

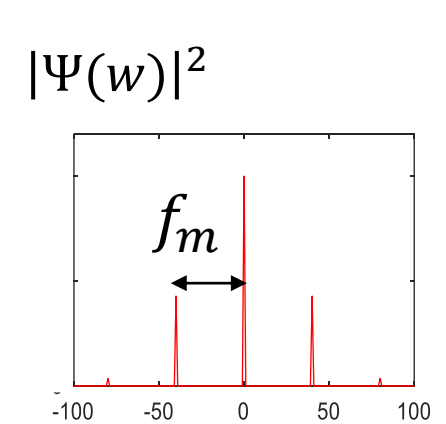


II. BESSELON PULSE GENERATION



Sinusoidal temporal phase

$$A_m \sin(2\pi f_m t)$$



Triangular spectral phase



Jacobi-Anger expansion

$$\psi(t) = \sum_{n=-\infty}^{\infty} J_n(A_m) e^{i n \omega_m t}$$

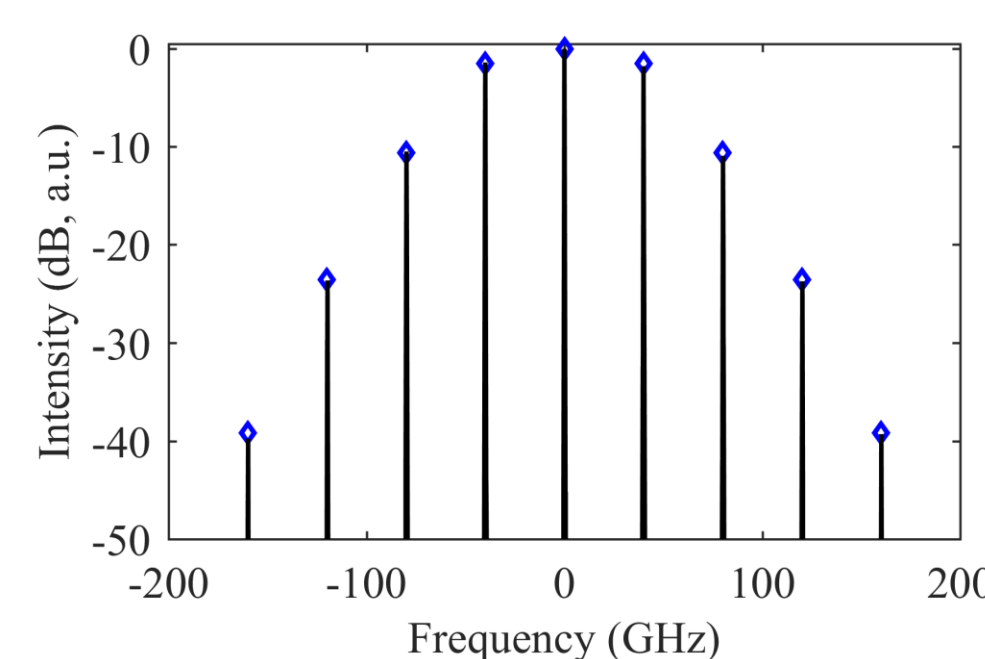
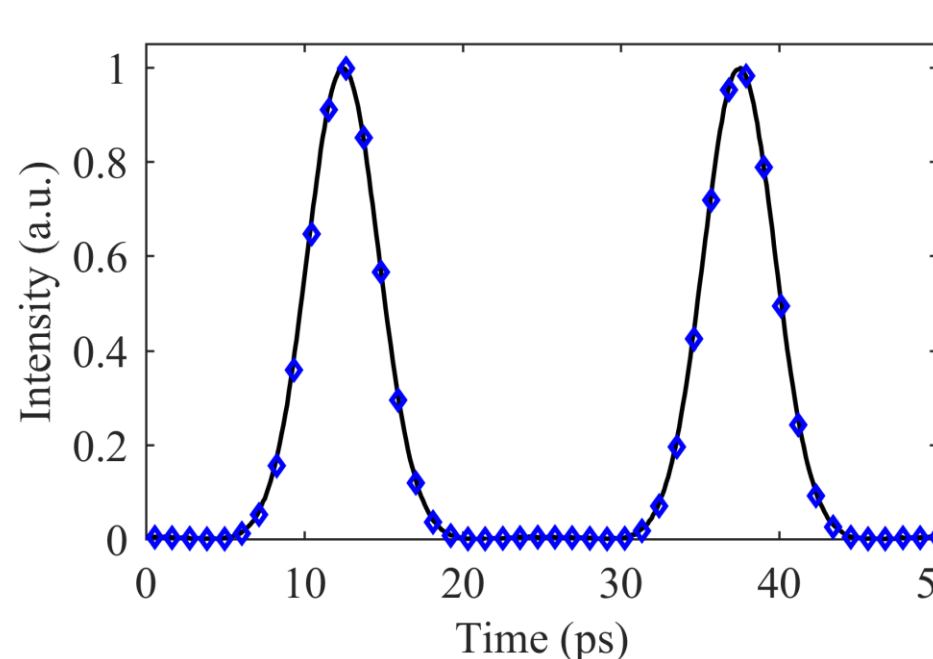
Bessel function of the first kind

$\pi/2$ phase shift between two subsequent harmonics

To produce a train of Fourier-transform-limited pulses a triangular spectral phase should be imprinted

— Theory
— Experiment

$$f_m = 40 \text{ GHz}, A_m = 1.22 \text{ rad}$$



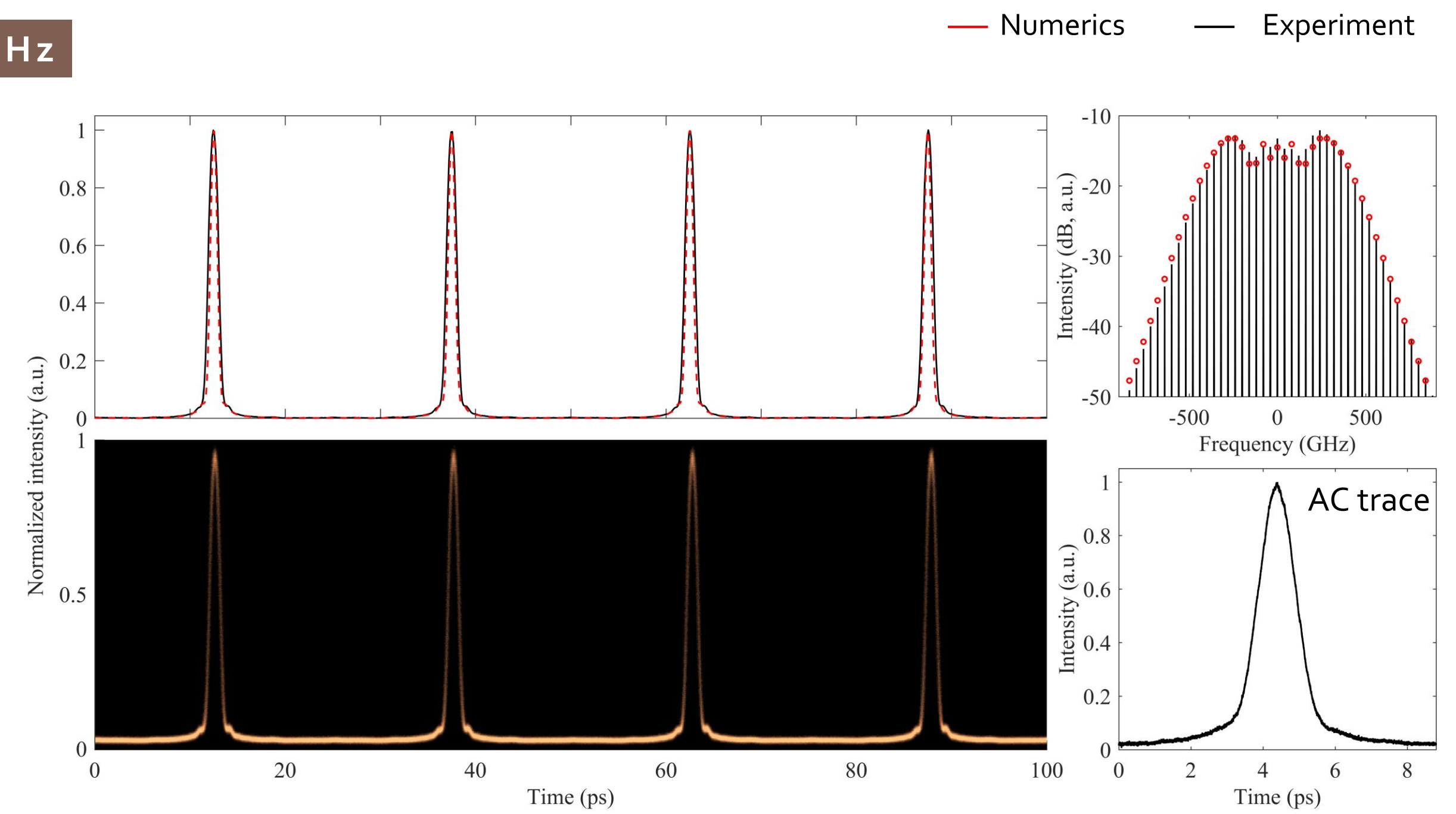
BESSELON

- Background-free
- FWHM = 5.4 ps
- Duty cycle = 0.22

For more details refer to : [3], [6]

III. NONLINEAR COMPRESSION

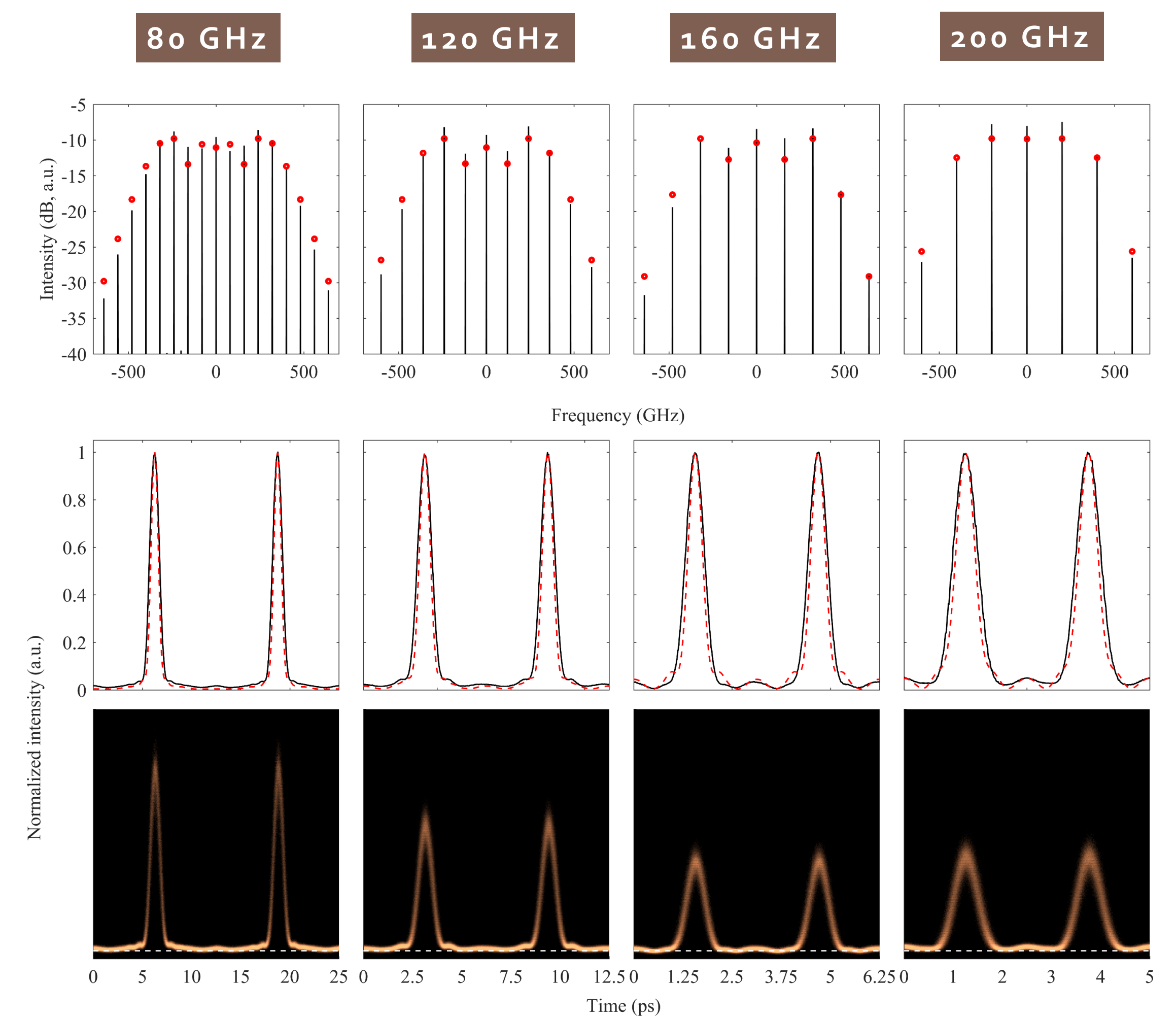
40 GHz



	Besselon	NL compressed pulse
FWHM, ps	5.4	0.9
Duty cycle	0.22	0.04

× 9 times improvement

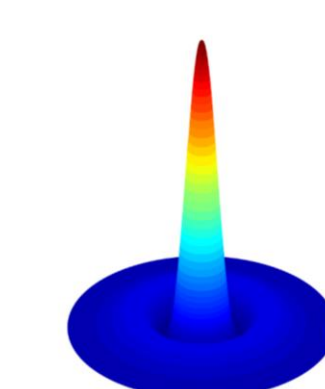
IV. REPETITION RATE MULTIPLEXING



	80 GHz	120 GHz	160 GHz	200 GHz
FWHM, ps	0.85	0.77	0.73	0.95
Duty cycle	0.07	0.09	0.12	0.19

CONCLUSION

- High extinction ratio ✓
- Low sidelobes ✓
- High repetition rate ✓
- Low duty cycle ✓



- Background-free pulse train
- Sub-ps pulses at (1 : 5) × 40 GHz
- All-optical setup of low complexity
- Significant improvement of the results

REFERENCES:

- [1] C. Finot, J. Fatome, S. Pitois, and G. Millot, "All-Fibered High-Quality Low Duty-Cycle 20-GHz and 40-GHz Picosecond Pulse Sources," IEEE Photon. Technol. Lett. **19**, 1711-1713 (2007).
- [2] T. Kobayashi, H. Yao, K. Amano, Y. Fukushima, A. Morimoto, and T. Sueta, "Optical pulse compression using high-frequency electrooptic phase modulation," IEEE J. Quantum Electron. **24**, 382-387 (1988).
- [3] U. Andral, J. Fatome, B. Kibler, and C. Finot, "Triangular spectral phase tailoring for the generation of high-quality picosecond pulse trains," Opt. Lett. **44**, 4913 (2019).
- [4] D. Grischkowsky and A. C. Balant, "Optical pulse compression based on enhanced frequency chirping," Appl. Phys. Lett. **41**, 1-3 (1982).
- [5] M. A. F. Roelens, S. Frisken, J. Bolger, D. Abakounov, G. Baxter, S. Poole, and B. J. Eggleton, "Dispersion trimming in a reconfigurable wavelength selective switch," J. Lightw. Technol. **26**, 73-78 (2008).
- [6] A. Sheveleva, U. Andral, B. Kibler, S. Boscolo, and C. Finot, "Temporal Optical Besselon Waves for High-Repetition Rate Picosecond Sources," arXiv:2003.12630 (2020).